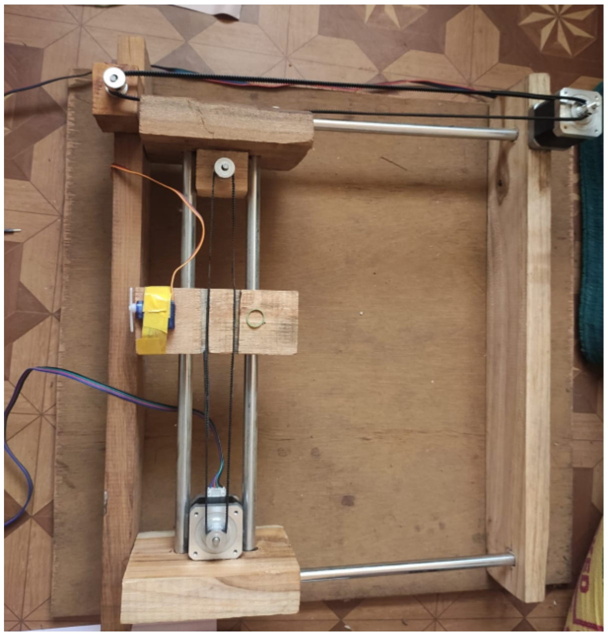
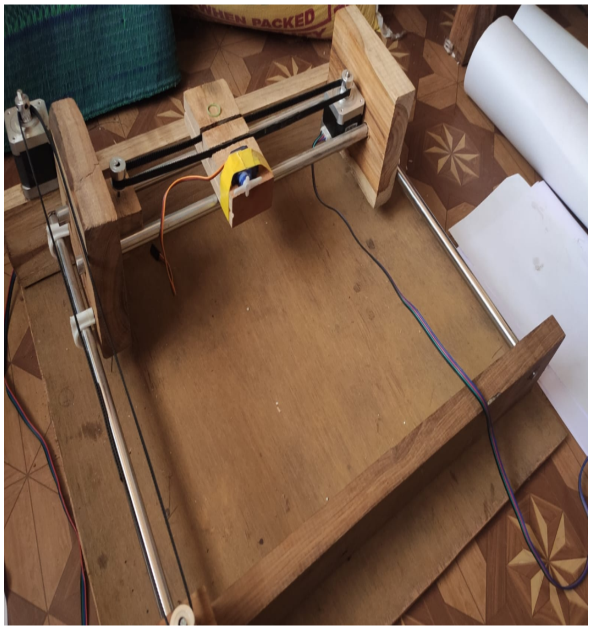
# XY Plotter

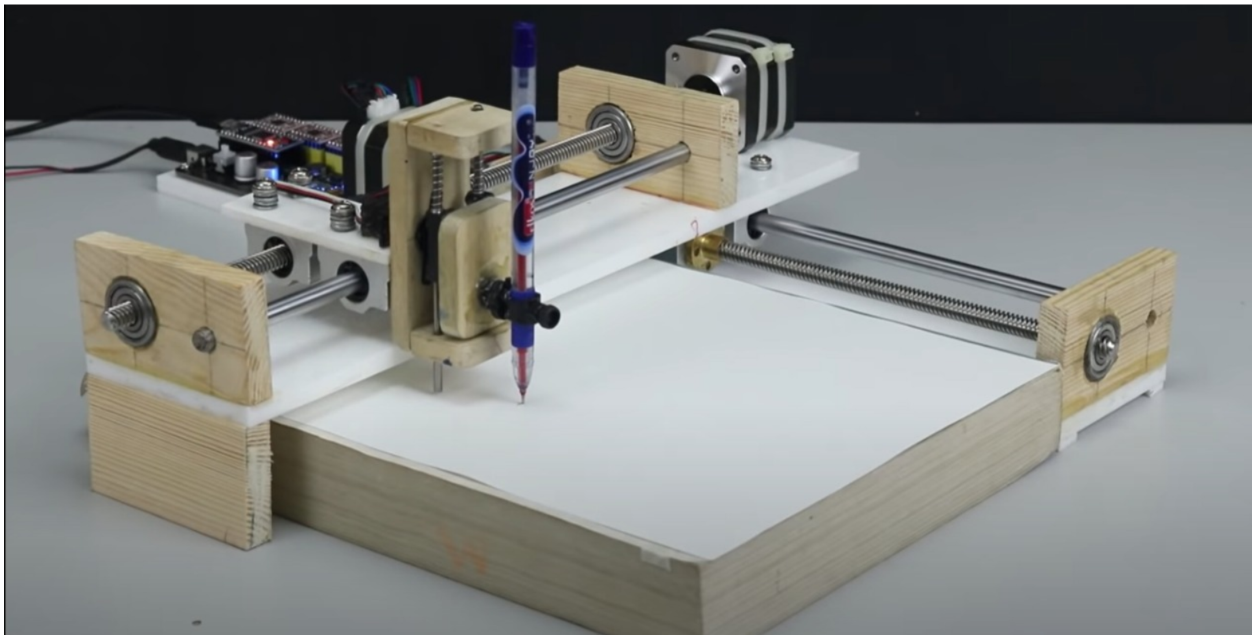
## Team members:

1. *Battu Lochana Janaki [CE18B003]*
2. *Siddarth Nilol K S [CE18B055]*
3. *Anurag Manu [EE19B062]*
4. *K N A Chaturvedi [EE19B086]*
5. *Mohak Khandelwal [ME19B195]*
6. *Rahul Batish [ME19B062]*
7. *Mohamed Shihad P [ED19B053]*

**Introduction:-***The project is about making a device for automatic designing of stuffs with the help of a pen which could help students in daily homeworks of drawing borders or designs. The components consisted of three parts: mechanical module, arduino and other electrical components and finally the code part. Though there are several models for plotters, this plotter is designed in an economical way. Main advantage of this plotter is we can replace the tool based on any application such as engraving machine, laser cutting machine, painting any surface and drawing purposes.*

## MODEL used for reference:



**Brief explanation:-** *The JPEG and PNG photo is converted into G-code and then it is feeded into the PC where it is used in arduino code and then the code makes the arduino to work on motor and to move the setup efficiently to make the design on the drawing sheet where the vertical motion of the pen is controlled by stepper motor.*

## Electric Module:-

### *Arduino:*

*We used UNO as it is the most used and documented board of the whole Arduino family. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs.*

### *Stepper motor:*

*We used NEMA17 4.2 kg-cm Stepper Motor for required motion in x,y axises.*

### *Servo motor:*

*Used Micro Servo Motor to control the pen i.e. to lift up or put down to draw.*

### *Stepper motor driver:*

*Used L298N Based Motor Driver as this Driver Module is a high power motor driver perfect for driving Stepper Motors.*

### *Smps:*

*Used 12V 5A SMPS to supply power for all components.*

**Mechanical Module:-** *The module was pretty basic. We fixed the DC motor to a wooden plank and wooden parts were used for providing a base for the penstand . Four rods and clippers were used for making the structure of the model perfect. Belts and pulleys were used to make the system run with the help of motors as shown in the diagram. Finally a stepper motor was used to make the pen movement in vertical direction (up and down).*

## Arduino Code:-

```
#include <Servo.h>
#include <AFMotor.h>

#define LINE_BUFFER_LENGTH 512

char STEP = MICROSTEP ;

// Servo position for Up and Down
const int penZUp = 115;
const int penZDown = 83;

// Servo on PWM pin 10
const int penServoPin =10 ;

// Should be right for DVD steppers, but is not too important here
const int stepsPerRevolution = 48;

// create servo object to control a servo
Servo penServo;

// Initialize steppers for X- and Y-axis using this Arduino pins for the L293D H-bridge
AF_Stepper myStepperY(stepsPerRevolution,1);
AF_Stepper myStepperX(stepsPerRevolution,2);

/* Structures, global variables    */
struct point {
  float x;
  float y;
  float z;
};

// Current position of plothead
struct point actuatorPos;

//  Drawing settings, should be OK
float StepInc = 1;
int StepDelay = 0;
int LineDelay =0;
int penDelay = 50;

// Motor steps to go 1 millimeter.
// Use test sketch to go 100 steps. Measure the length of the line.
// Calculate steps per mm. Enter here.
float StepsPerMillimeterX = 100.0;
float StepsPerMillimeterY = 100.0;
```

```
// Drawing robot limits, in mm
// OK to start with. Could go up to 50 mm if calibrated well.
float Xmin = 0;
float Xmax = 40;
float Ymin = 0;
float Ymax = 40;
float Zmin = 0;
float Zmax = 1;

float Xpos = Xmin;
float Ypos = Ymin;
float Zpos = Zmax;

// Set to true to get debug output.
boolean verbose = false;

//  Needs to interpret
//  G1 for moving
//  G4 P300 (wait 150ms)
//  M300 S30 (pen down)
//  M300 S50 (pen up)
//  Discard anything with a (
//  Discard any other command!

/**********************
 * void setup() - Initialisations
 ***********************/
void setup() {
  //  Setup

  Serial.begin( 9600 );

  penServo.attach(penServoPin);
  penServo.write(penZUp);
  delay(100);

  // Decrease if necessary
  myStepperX.setSpeed(600);
  myStepperY.setSpeed(600);

  //  Set & move to initial default position
  // TBD

  //  Notifications!!!
  Serial.println("Mini CNC Plotter alive and kicking!");
  Serial.print("X range is from ");
  Serial.print(Xmin);
  Serial.print(" to ");
  Serial.print(Xmax);
  Serial.println(" mm.");
  Serial.print("Y range is from ");
  Serial.print(Ymin);
  Serial.print(" to ");
  Serial.print(Ymax);
  Serial.println(" mm.");
}

/**********************
 * void loop() - Main loop
 ***********************/
void loop()
{

  delay(100);
  char line[ LINE_BUFFER_LENGTH ];
  char c;
  int lineIndex;
  bool lineIsComment, lineSemiColon;

  lineIndex = 0;
  lineSemiColon = false;
  lineIsComment = false;

  while (1) {

    // Serial reception - Mostly from Grbl, added semicolon support
    while ( Serial.available()>0 ) {
      c = Serial.read();
      if (( c == '\n') || (c == '\r') ) {             // End of line reached
        if ( lineIndex > 0 ) {                        // Line is complete. Then execute!
          line[ lineIndex ] = '\0';                   // Terminate string
          if (verbose) {
            Serial.print( "Received : ");
            Serial.println( line );
          }
          processIncomingLine( line, lineIndex );
          lineIndex = 0;
        }
        else {
          // Empty or comment line. Skip block.
        }
        lineIsComment = false;
        lineSemiColon = false;
        Serial.println("ok");
      }
      else {
        if ( (lineIsComment) || (lineSemiColon) ) {   // Throw away all comment characters
          if ( c == ')' )  lineIsComment = false;     // End of comment. Resume line.
        }
        else {
          if ( c <= ' ' ) {                           // Throw away whitespace and control characters
          }
          else if ( c == '/' ) {                    // Block delete not supported. Ignore character.
          }
          else if ( c == '(' ) {                    // Enable comments flag and ignore all characters until ')' or EOL.
            lineIsComment = true;
          }
          else if ( c == ';' ) {
            lineSemiColon = true;
          }
          else if ( lineIndex >= LINE_BUFFER_LENGTH-1 ) {
            Serial.println( "ERROR - lineBuffer overflow" );
            lineIsComment = false;
            lineSemiColon = false;
          }
          else if ( c >= 'a' && c <= 'z' ) {        // Upcase lowercase
            line[ lineIndex++ ] = c-'a'+'A';
          }
          else {
            line[ lineIndex++ ] = c;
          }
        }
      }
    }
  }
}

void processIncomingLine( char* line, int charNB ) {
  int currentIndex = 0;
  char buffer[ 64 ];                                 // Hope that 64 is enough for 1 parameter
  struct point newPos;

  newPos.x = 0.0;
  newPos.y = 0.0;

  //  Needs to interpret
  //  G1 for moving
  //  G4 P300 (wait 150ms)
  //  G1 X60 Y30
  //  G1 X30 Y50
  //  M300 S30 (pen down)
  //  M300 S50 (pen up)
  //  Discard anything with a (
  //  Discard any other command!

  while( currentIndex < charNB ) {
    switch ( line[ currentIndex++ ] ) {              // Select command, if any
    case 'U':
      penUp();
      break;
    case 'D':
      penDown();
      break;
    case 'G':
      buffer[0] = line[ currentIndex++ ];          // /!\ Dirty - Only works with 2 digit commands
      //      buffer[1] = line[ currentIndex++ ];
      //      buffer[2] = '\0';
      buffer[1] = '\0';

      switch ( atoi( buffer ) ){                   // Select G command
      case 0:                                   // G00 & G01 - Movement or fast movement. Same here
      case 1:
        // /!\ Dirty - Suppose that X is before Y
        char* indexX = strchr( line+currentIndex, 'X' );  // Get X/Y position in the string (if any)
        char* indexY = strchr( line+currentIndex, 'Y' );
        if ( indexY <= 0 ) {
          newPos.x = atof( indexX + 1);
          newPos.y = actuatorPos.y;
        }
        else if ( indexX <= 0 ) {
          newPos.y = atof( indexY + 1);
          newPos.x = actuatorPos.x;
        }
        else {
          newPos.y = atof( indexY + 1);
          indexY = '\0';
          newPos.x = atof( indexX + 1);
        }
        drawLine(newPos.x, newPos.y );
        //        Serial.println("ok");
        actuatorPos.x = newPos.x;
        actuatorPos.y = newPos.y;
        break;
      }
      break;
    case 'M':
      buffer[0] = line[ currentIndex++ ];        // /!\ Dirty - Only works with 3 digit commands
      buffer[1] = line[ currentIndex++ ];
      buffer[2] = line[ currentIndex++ ];
      buffer[3] = '\0';
      switch ( atoi( buffer ) ){
      case 300:
        {
          char* indexS = strchr( line+currentIndex, 'S' );
          float Spos = atof( indexS + 1);
          //         Serial.println("ok");
          if (Spos == 30) {
            penDown();
          }
          if (Spos == 50) {
            penUp();
          }
          break;
        }
      case 114:                              // M114 - Report position
        Serial.print( "Absolute position : X = " );
        Serial.print( actuatorPos.x );
        Serial.print( "  -  Y = " );
        Serial.println( actuatorPos.y );
        break;
      default:
        Serial.print( "Command not recognized : M");
        Serial.println( buffer );
      }
    }
```

```
  }
}

/**********************************
 * Draw a line from (x0;y0) to (x1;y1).
 * int (x1;y1) : Starting coordinates
 * int (x2;y2) : Ending coordinates
 **********************************/
void drawLine(float x1, float y1) {

  if (verbose)
  {
    Serial.print("fx1, fy1: ");
    Serial.print(x1);
    Serial.print(",");
    Serial.print(y1);
    Serial.println("");
  }

  //  Bring instructions within limits
  if (x1 >= Xmax) {
    x1 = Xmax;
  }
  if (x1 <= Xmin) {
    x1 = Xmin;
  }
  if (y1 >= Ymax) {
    y1 = Ymax;
  }
  if (y1 <= Ymin) {
    y1 = Ymin;
  }

  if (verbose)
  {
    Serial.print("Xpos, Ypos: ");
    Serial.print(Xpos);
    Serial.print(",");
    Serial.print(Ypos);
    Serial.println("");
  }

  if (verbose)
  {
    Serial.print("x1, y1: ");
    Serial.print(x1);
    Serial.print(",");
    Serial.print(y1);
    Serial.println("");
  }

  //  Convert coordinates to steps
  x1 = (int)(x1*StepsPerMillimeterX);
  y1 = (int)(y1*StepsPerMillimeterY);
```

```
float x0 = Xpos;
float y0 = Ypos;

//  Let's find out the change for the coordinates
long dx = abs(x1-x0);
long dy = abs(y1-y0);
int sx = x0<x1 ? StepInc : -StepInc;
int sy = y0<y1 ? StepInc : -StepInc;

long i;
long over = 0;

if (dx > dy) {
  for (i=0; i<dx; ++i) {
    myStepperX.onestep(sx,STEP);
    over+=dy;
    if (over>=dx) {
      over-=dx;
      myStepperY.onestep(sy,STEP);
    }
  delay(StepDelay);
  }
}
else {
  for (i=0; i<dy; ++i) {
    myStepperY.onestep(sy,STEP);
    over+=dx;
    if (over>=dy) {
      over-=dy;
      myStepperX.onestep(sx,STEP);
    }
    delay(StepDelay);
  }
}

if (verbose)
{
  Serial.print("dx, dy:");
  Serial.print(dx);
  Serial.print(",");
  Serial.print(dy);
  Serial.println("");
}

if (verbose)
{
  Serial.print("Going to (");
  Serial.print(x0);
  Serial.print(",");
  Serial.print(y0);
  Serial.println(")");
}

//  Delay before any next lines are submitted
```

```
  delay(LineDelay);
  //  Update the positions
  Xpos = x1;
  Ypos = y1;
}

//  Raises pen
void penUp() {
  penServo.write(penZUp);
  delay(penDelay);
  Zpos=Zmax;
  digitalWrite(15, LOW);
    digitalWrite(16, HIGH);
  if (verbose) {
    Serial.println("Pen up!");

  }
}
//  Lowers pen
void penDown() {
  penServo.write(penZDown);
  delay(penDelay);
  Zpos=Zmin;
  digitalWrite(15, HIGH);
    digitalWrite(16, LOW);
  if (verbose) {
    Serial.println("Pen down.");
  }
}
```

1) *We initialise variables and starting points and objects for controlling the servo.Void setup() is used for initialization purpose.*
2) *We create the void loop() to cater the need for the iteration in which we call the processIncomingLine() to process the current line and according to the line index.*
3) *drawLine() is used to draw the lines for the incoming coordinates where x1,y1 is the starting coordinates and x2,y2 is the ending coordinates.*
4) *Void penUp() and penDown() raises and lowers the pen.If servo works in the opposite direction, switch the value of penUp & penDown values.*
5) *Xmax & Ymax values are changed depending upon the plotting area.*
6) *StepInc is used to change the speed of a cnc plotter machine. The value of StepDelay can be varied from 0 to 2, 0 is for maximum speed and 2 is for minimum speed, ideally kept at 1.*
7) *As of now code is uploaded and G-code is to be generated.*
8) *Press the "Run on Arduino" button.*

## G-Code Generation:-

*1)To draw something with CNC plotter machine we obviously need G-code,*
*G-code is the language of the CNC machine.*
*2)In this project we are using Inkscape software and makerbot G-code library to generate G-code of image.*
*3)Drag and drop the arduino image in Inkscape and resize the image to fit the printing area. Click Path from menu and "Trace Bitmap".*
*4)Click from the Path menu "Object to path".*
*5)Finally click save as and select .gcode.*

## GCTRL:-

*1) At this point our machine is ready to plot anything just waiting for command, we also have generated a G-code but have to send this G-code to the machine.*
*2)For this job we used GCTRL a G-code sender GUI for processing.*
*3)Simply open the GCTRL.pde by double clicking on it.All the details regarding how to use this GUI is clearly written there itself.*
*4)By pressing the key “p” we select the COM port from the drop down list.*
*5)To send G-code to the Arduino press key “g”, select the G-code file and hit enter, the machine starts to plot the drawing*.

## Issues Faced:-

- *Movement along the axis was not smooth.*
- *Also as movement is driven due to pulling due to which there is a slight variation in one of the sides compared to the side where the stepper is attached.*
- *Code wasn’t compatible with the structure.*

**Acknowledgment:-** *First of all, the xy plotter project of Envisage was the inspiration. The code and theory credits go to the same. This project “XY plotter” was under “Shows vertical of Envisage‘. We would like to thank our cores Ashutosh Patil and Jeeva for their support throughout the tenure. We extend our thanks to all the other super coordinators who were beside us the whole time. Lastly, we would like to thank all our fellow coordinators for appreciating and helping us whenever we required them. Thanks, everyone for making it a wonderful experience working for Envisage.*